

REMARKS

Favorable reconsideration of this application, in light of the preceding amendments and the following remarks, is respectfully requested.

Claims 1-26 are pending in this application. Claim 23 is amended, and claim 26 is newly added. No claims have been cancelled. This amendment does not raise new issues requiring further consideration and/or search. It is therefore respectfully requested that the present amendment be entered under 37 C.F.R. §1.116. Applicants respectfully submit that no new matter is added by this amendment.

Applicants note with appreciation the indication of allowable subject matter in dependent claims 7-18 and 22.

The Applicants note with appreciation the Examiner's acknowledgement that certified copies of all priority documents have been received by the USPTO. Action summary at 12.

The Applicants also respectfully note that the present action does not indicate that the drawings have been accepted by the Examiner. The Applicants respectfully request that the Examiner's next communication include an indication as to the acceptability of the filed drawings or as to any perceived deficiencies so that the Applicants may have a full and fair opportunity to submit appropriate amendments and/or corrections to the drawings.

SPECIFICATION

The specification is amended herewith to correct minor informalities. More specifically, paragraphs [0068] and [0071] on page 21 and page 23, respectively, are amended to correctly identify the figures described therein.

The Applicants hereby confirm their willingness to cooperate with the Examiner in the identification and correction of further minor errors within the specification. The

Applicants respectfully submit, however, that they are not presently aware of any such errors that would require correction.

REJECTIONS UNDER 35 U.S.C. § 102

Claims 23 and 24 stand rejected under 35 U.S.C. § 102(b) as anticipated by Lee et al. (U.S. Patent No. 6,277,722, herein Lee). The Applicants respectfully traverse this rejection for the reasons detailed below.

Amended Claim 23 recites a semiconductor device including “a semiconductor substrate; a gate insulator formed on the semiconductor substrate; and a metal gate pattern formed on the gate insulator.” More specifically, the metal gate pattern has a top service and substantially vertical sidewalls and includes a first conductor pattern having a first oxidation rate, a second conductor pattern having a second oxidation rate, and a capping layer. Further, in the metal gate pattern recited in amended claim 23, “the first oxidation rate of the first conductor pattern is enhanced relative to the second oxidation rate of the second conductor pattern.” (Emphasis added).

Lee describes a method for forming a polymetal gate including forming a capping layer, etching the capping layer to remain only on the sidewalls, heating the polymetal gate to repair damage of the capping layer resulting from the etching process, and then performing a reoxidation process.¹ Lee states “because the damage of the nitride film which remains in the sidewalls of the polymetal gate 20 is recovered through the previous heat treatment, the penetration of the oxidizing gas through the exposed portion of the tungsten film 13 is prevented in the reoxidation process.”² According to the above-cited language of Lee, and

¹ Lee, Abstract.

² Lee, Col. 3, Lines 28-34.

illustrated by the differences shown in Figures 3 and 4 of Lee, the repaired nitride sidewalls prevent the reoxidation step from having any effect on the gate pattern. In other words, only the gate oxide layer 11 on the sides of the gate pattern is modified during the reoxidation process. Therefore, Applicants respectfully submit that Lee fails to disclose a structure, wherein the oxidation rate of the polysilicon layer 12 is enhanced relative to metal layers 13 or 14. Even if the Examiner cites Lee as inherently disclosing that a polysilicon layer 12 has a first oxidation rate and the metal layers 13 and 14 have a second oxidation rate, Lee does not disclose, teach, or suggest a structure, wherein the first oxidation rate is enhanced relative to the second oxidation rate.

Accordingly, Applicants respectfully submit that Lee fails to disclose, teach, or suggest the metal gate pattern of the semi-conductor device of amended claim 23 reciting, *inter alia*, “the first oxidation rate of the first conductor pattern of the metal gate pattern is enhanced relative to the second oxidation rate of the second conductor pattern.” Because claim 24 depends from amended claim 23, the same arguments apply.

The Applicants, therefore, respectfully request that the rejection to Claims 23 and 24 under 35 U.S.C. § 102(b) be withdrawn.

REJECTIONS UNDER 35 U.S.C. § 103

Claims 1-6, 19-20, and 25 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Lee in view of Kobayashi et al. (U.S. Patent No. 4,505,028 herein Kobayashi). The Applicants respectfully traverse this rejection for the reasons detailed below.

Claim 1 recites a method for fabricating a semiconductor device having a metal gate pattern including:

forming a gate insulating layer having an initial thickness on a silicon substrate;
depositing a metal gate material on the gate insulating layer, the metal gate material including at least one metal layer;
etching the metal gate material to form a metal gate pattern;
forming a capping layer on the metal gate pattern; and
selectively oxidizing at least a portion of the silicon substrate without substantially oxidizing the at least one metal layer and without substantially increasing the initial thickness of the gate insulating layer." (Emphasis added).

As illustrated by the comparison of the conventional devices illustrated in Figures 2A and 2B with the semiconductor devices developed according to the method of claim 1 shown in Figures 12A and 12B, the selectively oxidizing step of claim 1 oxidizes the at one metal layer "without substantially increasing the initial thickness of the gate insulating layer."³ As shown in the non-limiting example of Figure 12B, the gate oxide layer is only increased from a thickness of 55 Å to 63 Å, whereas the conventional oxidation processes increase the gate oxide layer from 55 Å to 90 Å, approximately doubling the thickness of the gate oxide layer.

The outstanding Office Action on page 5, lines 10-16, acknowledges that Lee fails to disclose "selectively oxidizing at least a portion of the silicon substrate without substantially oxidizing the at least one metal layer and without substantially increasing the initial thickness of the gate insulating layer" and relies on the teachings of Kobayashi for this feature of claim 1.

In addition to the above-identified deficiency of Lee, Applicants respectfully submit that Lee teaches away from the method recited in claim 1. More specifically, Lee states "the technique using the capping layer has a disadvantage in that the exposed portion of the tungsten is oxidized as usual in the following reoxidation in spite of the formation of the

³ Applicants' specification at least at page 23, paragraph [0071].

nitride film for oxidation prevention.”⁴ In other words, Lee states that forming sidewalls (capping layer) without heating the sidewalls prior to oxidization has no effect since the sidewalls are damaged and the oxidizing gas will penetrate the damaged sidewalls causing adverse effects. Accordingly, Applicants respectfully submit that an essential feature of the method of Lee is the heating process completed after the forming of the sidewalls and prior to the oxidization of the substrate. Therefore, Applicants respectfully submit that Lee teaches away from the method of the claimed invention.

With respect to the proposed combination of Lee and Kobayashi, Applicants respectfully submit that the combination is improper for at least the following reasons.

Lee is directed to preventing migration of the oxidizing gases through the nitride sidewalls, which must be repaired during a heating process, whereas the teachings of Kobayashi describe that selective oxidation may be used to oxidize “silicon alone without substantially oxidizing tungsten, molybdenum or their silicides.”⁵ Therefore, according to the teachings of Kobayashi, there is no need for the sidewalls or repairing the sidewalls since silicon can be selectively etched without effecting metals such as tungsten. Accordingly, Applicants respectfully submit there is insufficient evidence in the record for modifying the method of forming an integrated circuit of Lee to incorporate the selective oxidation step of Kobayashi. Additionally, neither Lee nor Kobayashi recognize the problems or solution thereto regarding the increase in thickness of a gate insulating layer within the metal gate pattern.

Further, Applicants respectfully submit that an attempt to bring in the isolated teachings of the selective oxidation step of Kobayashi into the method for forming an

⁴ Lee, column 2, lines 3-6.

⁵ Kobayashi, column 2, lines 35-37.

integrated circuit of Lee would amount to improperly picking and choosing from the different references without regard for the teachings of the references as a whole.⁶ In addition, Applicants respectfully submit that incorporating the selective oxidation step of Kobayashi into the method of forming an integrated circuit described in Lee would change the basic principle of the operation of the method described in Lee, which is to prevent oxidation of the metal gate by creating sidewalls and heating the sidewalls to repair damage incurred during the formation of the sidewalls.

Still further, Applicants respectfully submit that even if one skilled in the art is motivated to combine the references of Lee and Kobayashi, the result of the combination would likely be the elimination of Lee's sidewalls (i.e. the capping layer). Therefore, the combination of Lee and Kobayashi would still not teach or suggest the features of claim 1.

The Applicants maintain, therefore, that the Action does not present the required "convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references," *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985), and that this rejection may not be properly maintained absent such reasoning.

Claims 2-6, 19, and 20 depend from claim 1 and claim 25 recites features similar to claim 1. Therefore, the arguments discussed above regarding the deficiencies of Lee with respect to independent claim 1 and the improper combination of Lee and Kobayashi also apply to claims 2-6, 19, 20, and 25.

⁶ See In re Ehrreich 590 F2d 902, 200 USPQ 504 (CCPA, 1979) (stating that patentability must be addressed "in terms of what would have been obvious to one of ordinary skill in the art at the time the invention was made in view of the sum of all the relevant teachings in the art, not in view of first one and then another of the isolated teachings in the art," and that one "must consider the entirety of the disclosure made by the references, and avoid combining them indiscriminately.")

Accordingly, Applicants respectfully request that the rejection to claims 1-6, 19, and 20 and 25 under 35 U.S.C. § 103(a) be withdrawn.

Claim 21 stands rejected under 35 U.S.C. § 103(a) as unpatentable over Lee in view of Kobayashi, and further in view of Hwang et al. (U.S. Patent No. 6,245,605, herein Hwang). The Applicants respectfully traverse this rejection for the reasons detailed below.

The Applicants respectfully incorporate the discussion above with respect to the deficiencies of both Lee and Kobayashi and with respect to the lack of motivation to make the proposed combination of method steps suggested by the Examiner.

Further, Applicants respectfully submit that Hwang, like Kobayashi, utilizes selective oxidation to avoid the need to form the protective sidewalls of Lee during the reoxidation process and, therefore, would not provide one of ordinary skill in the art with the requisite motivation to make the proposed combination for the reasons discussed above in connection with Kobayashi. Further, the Applicants respectfully contend that even were such a combination to be made, the teachings of Hwang are not sufficient to remedy the noted deficiencies in Lee and Kobayashi.

Accordingly, Applicants respectfully request that the rejection of claim 21 under 35 U.S.C. § 103 be withdrawn.

ALLOWABLE SUBJECT MATTER

The Applicants note with appreciation the Examiner's indication that claims 7-18 and 22 are objected to as being dependent from a rejected based claim, and would, therefore, be allowable if rewritten in independent form incorporating limitations of all included claims. As reflected by the remarks above, however, the Applicants respectfully maintain that the

remaining claims are also allowable for at least the same reasons as independent claim 1 and that no such rewriting of claims 7-18 and 22 is warranted at this time.

NEW CLAIMS

Claim 26 has been added in an effort to provide further protection for the Applicants' invention. Claim 26 includes features similar to claim 1, and therefore is patentably distinguished over the cited references of record for at least the same reasons as discussed above with respect to claim 1. Accordingly, claim 26 is believed to be in condition for formal allowance.

CONCLUSION

In view of the above remarks and amendments, the Applicants respectfully submit that each of the pending objections and rejections have been addressed and overcome, leaving the present application for condition for formal allowance. A notice to that effect is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to contact the undersigned.

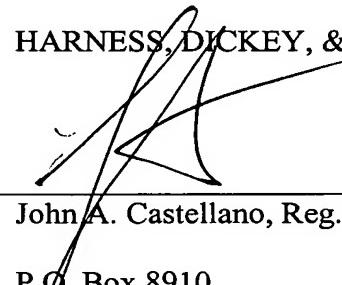
If necessary, the Commissioner is hereby authorized and in this, concurrent, and future replies, to charge any under payment or non-payment of any fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17, or credit any overpayment of such fees, to Deposit Account No. 08-0750, including, in particular, extension of time fees.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John A. Castellano at the telephone number of the undersigned below.

Respectfully submitted,

HARNESS, DICKEY, & PIERCE, P.L.C.

By


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